## Symptoms.

*Puccinia antirrhini* is able to attack all above ground parts of the plant except the petals. On the leaves, the first sign of infection is usually a small yellowish spot seen on the under surface. This gradually enlarges to form a shiny, brown, slightly raised blister, about 1 mm. in diameter, which finally breaks through the leaf epidermis as a reddish-brown uredosorus. Quite often, later uredosori are produced in rings around the initial one, giving a distinctive pattern (Plate vii, 1). Sometimes, corresponding to the masses of uredosori on the underside, a chlorotic area can be seen on the upper side of the leaf (Plate vii, 2). As the season progresses, the leaf pustules darken and the leaves become covered with black teleutosori.

Stems and petioles are also attacked and uredosori have been observed on the sepals of young buds (Plate vii, 3). On the stems the pustules consist largely of teleutosori, which often completely encircle the stems. In later stages of infection plants may be almost completely covered with rust pustules (Plate vii, 5).

Quite commonly on infected leaves necrotic areas are seen to develop, especially where many uredosori are massed together on the underside of the leaf (Plate vii, 4). This effect has been noted in America by Dimock and Baker (1951), who found that, under semi-arid conditions, injury resulted almost entirely from drying out of the rust-invaded tissues. They found, however, that where the humidity was high and rainfall frequent, damage was caused by facultative parasites entering through the rust pustules and advancing into previously healthy tissue. In New South Wales the main cause of these necrotic areas seems to be drying out of the tissues during hot weather.

An interesting observation was made by Fikry (1938) in Egypt, who found teleutosori occurring on the roots of some heavily infected snapdragon plants. No such occurrence has been observed during this work.

## The Causal Fungus.

The uredospores of the Australian isolate of *P. antirrhini* (Text-fig. 1, A) are roughly spherical to slightly elongated in shape, and measure $19–27\mu \times 19–23\mu$ (mean of 20 measurements: $23\mu \times 21\mu$). The outer wall is finely echinulate, $1\frac{1}{2}–3\mu$ thick, and penetrated by 2–3 germ pores which are sometimes arranged in an equatorial plane around the spore but often appear to occur irregularly. The spore wall is slightly thicker at the point of attachment of the stalk.

The teleutospores are of two main types (Text-fig. 1, B). One type is short and measures $30–42\mu \times 21–27\mu$ (mean of 20 measurements: $36\mu \times 23\mu$). It has a blunt apical cell, quite thick at the top and dark reddish-brown in colour. The other type is longer, measuring $43–57\mu \times 17–21\mu$ (mean of 20 measurements: $49\mu \times 19\mu$), and has a more or less acute apical cell. This cell is lighter in colour than the apical cell of the shorter type. Other workers have noticed these two teleutospore types in *P. antirrhini* (Doidge, 1941).

Both types of teleutospore are constricted at the septum, tapering or somewhat rounded towards the base, and with a long pedicel, up to $95\mu$ long. In both the top cell is darker in colour than the basal cell. The germ pore in the top cell is apical and in the basal cell obscure.

Locally produced uredospores germinate readily in 18 hours when dusted onto water or a dilute aqueous extract of antirrhinum leaves and incubated at 10°C., but so far it has not been found possible to germinate teleutospores. Some workers (Green, 1941; Mains, 1924) have succeeded in germinating them, however, but have been unable to reinfect *Antirrhinum* or infect any other plant with them. It thus appears probable that *P. antirrhini* is a heteroecious rust whose alternate host has not yet been found. Mains (1924) discusses this in some detail. The alternate host is not necessary, however, as the rust is able to persist by means of continual infection of *Antirrhinum* with its uredospore stage.

*Physiologic Specialization.*

As with other rust fungi, various races of *P. antirrhini* have been found. Up till 1937 only one race of this rust was known, but in that year Yarwood (1937), working with excised leaves of various snapdragon varieties, demonstrated in America the existence of another race. This new race was known as race 2, the original being race 1. Race 2 proved to be more virulent than race 1 and was able to attack all those varieties that were hitherto resistant to the disease and, at the present time, there are no commercial lines of snapdragon resistant to race 2. Apart from these two races, it is quite possible that others also exist. Baker (1953, personal communication) stated that work done in California indicated clearly that other races are present there.

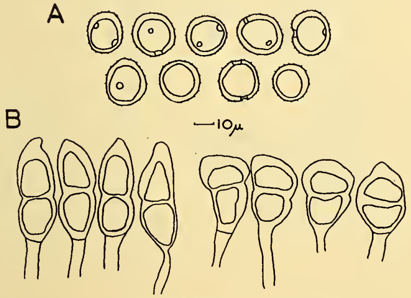


Figure 1.

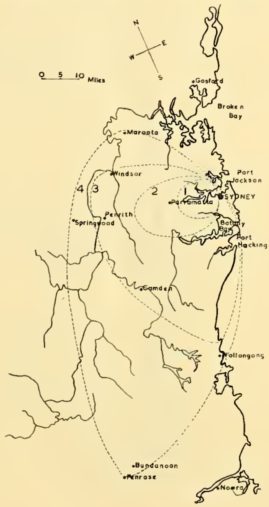


Figure 2.

Text-fig. 1.—(A) uredospores and (B) teleutospores of *P. antirrhini.*

Text-fig. 2.—Map showing initial zones of spread of Antirrhinum rust in New South Wales.

As far as can be determined, race 2 of *P. antirrhini* has been reported to date only in America and Southern Rhodesia. In other parts of the world where this rust has been recorded, race 1 appears to be the race present and, in these areas, the resistant varieties are still quite successful.

Tests were conducted to identify the race of rust present in New South Wales and to test the reaction of a number of snapdragon varieties to inoculation with this race.

*Method*:

All plants to be tested were raised from seed in four-inch pots in a glasshouse, hardened in a frame outside and then inoculated in the frame by dusting with heavily rusted plants. Plants were kept damp, giving optimum conditions for rust infection.

*Results*:

Inoculation results are summarized in Table 1. All varieties tested were quite susceptible to the local rust isolate and, although some variation in reaction did occur, all were quite heavily rusted. In the table those varieties classed as "fully susceptible" showed profuse uredosorus development, with practically no chlorosis visible on the upper side of the leaf. With those classed as "susceptible" some chlorosis was visible on the upper side of the leaf and in some cases the uredosori were slightly smaller than those on the "fully susceptible" types.

Of the varieties listed in Table 1, Watkins and Simpson's Pink Freedom, Wisley Bridesmaid, Wisley Cheerful and Wisley Golden Fleece were sent out by Mr. D. Green of Wisley, England, and No. 61 by Dr. K. F. Baker of California. These five varieties were strain-1 resistant types and, as is seen from the table, they were quite susceptible to the local rust race. This indicates that the race of *P. antirrhini* present in Australia is not race 1, but is similar to the virulent race 2.

Two varieties of *Linaria*, Excelsior Hybrid and Fairy Bouquet, were also inoculated with rust. Both showed no sign of infection. In the United States, Blasdale (1903) recorded *P. antirrhini* on two species of *Linaria*.

TABLE 1.

*Results of Antirrhinum Rust Inoculations. List of Varieties Tested and Their Reaction.*

| Fully Susceptible. | Susceptible. |
|---|---|
| Campfire. | Copper King. |
| Defiance. | Giant Ruffled Tetraploid. |
| Grandiflorum Rust-proof de Luxe Mixture. | Giant Skyscraper. |
| Queen Victoria. | Grandiflorum Rust Proof de Luxe. |
| Rust Resistant Autumn Glow Shades. | Grandiflorum Rust Resistant University of California de Luxe Mixture. |
| Rust Resistant Orange Shades. | Grandiflorum University of California. |
| Rust Resistant Tall Mixed. | Hybrids Mixed. |
| Rust Resistant Yellow. | Luteum. |
| Snowflake. | No. 61. |
| Tango. | Rose Marie. |
| Tetraploid Rust Resistant Selected Superfine Mixed. | Ruby. |
| University of California Mixed. | Rust Proof de Luxe Mixture. |
| University of California Rust Resistant Mixed. | Rust Proof Good Mixed. |
| Watkins' and Simpson's Pink Freedom. | Rust Resistant Spotlight. |
| Wisley Bridesmaid. | The Rose. |
| Wisley Cheerful. | Yellow King. |
| Wisley Golden Fleece. | Yellow Wonder. |
| World Favourite. | |

## UREDOSPORE LONGEVITY.

In the literature on the longevity of uredospores of rust fungi, one of the most important points made is the variation in the life of the uredospores under varying conditions of temperature and humidity. With *Puccinia antirrhini* the life of uredospores has been given from as short as six to eight weeks (Green, 1941) to as long as almost a year (Baker, 1953, personal communication). Because of the importance of the length of life of this spore stage, tests have been carried out to determine the longevity of locally produced spores.

Leaves bearing uredosori were collected from plants growing outside and, after drying at room temperature for 24 hours, were stored in closed jars at three different relative humidities: 25%, 50% and 75%. The humidity was controlled by sulphuric acid/water mixtures. Jars at each humidity were incubated at each of five different temperatures: 5°, 10°, 20°, 25° and 30°C., giving fifteen different treatments in all. Spore samples were taken at regular intervals and their germination tested by dusting onto the surface of a dilute aqueous extract of antirrhinum leaves in a Syracuse dish and incubating at 10°C. The antirrhinum leaf extract was used in preference to plain water as preliminary tests showed that much better germination was obtained with it.

Results of the germination tests are shown in Table 2. It is readily seen that the temperature and relative humidity under which the spores are kept considerably influence their longevity. Best germination occurred after storage at the lower temperatures and relative humidities, and as each rose a falling off in the life of the